Broadcast Signal Lab

Review of Application
of Verizon Wireless
for a Wireless Communications Facility
at 820 Main Street, Acton, Massachusetts

Background

Broadcast Signal Lab, LLP was engaged by the Town of Acton, Massachusetts Planning Board to assist with the review of the proposed Wireless Communication Facility (WCF) at 820 Main Street. The facility, proposed by personal wireless service provider Verizon Wireless, consists of a replacement to an existing tower on the site and the addition of certain ground facilities. The existing tower is a lightweight truss style tower ("lattice" tower) 120 feet tall. It supports an antenna employed by the business occupying the property. That antenna will be relocated to the top of the replacement tower.

The position of the replacement tower is at a location on the parcel different from the current tower. It is indicated as being 400 feet minimum from any residential property. The applicant proposes a "standard monopole," by which it means that the monopole tower would have wide antenna mounting platforms or racks (approximately 12 feet wide) at the top of the tower. The applicant is willing to be directed to employ a surface-mount antenna configuration and less willing to be directed to employ a concealed-antenna monopole design. As discussed at the February 13, 2007 hearing of the Planning Board, wireless companies lose flexibility to adapt their services and may lose a degree of overall wireless performance when compacting the antenna arrays into narrower spaces. To select the optimum design, the Board must balance the relative improvement in its visual impact on the character of the area against the relative diminution in quality of service to subscribers.

The proposed facility is intended as a substitute for their facility at 982-988 Main Street (the McKay parcel). This facility is attached to a tower owned and operated by Crown Castle Atlantic and occupied by numerous personal wireless services. A dispute between Crown and the landowner, McKay, has prevented the installation of upgraded telecommunications utilities to support the additional bandwidth the applicant desires to interconnect its facility with its network. The applicant is rolling out a data service, delivered by the technology called EVDO and

transmitted on their PCS radio spectrum. The applicant indicates that it would not require the proposed facility if there were a prompt resolution to the bandwidth shortage at the McKay site. Attempts have been made by the applicant and others to promote a resolution of the matter between Crown and McKay.

Two Extremes:

Bypass Easement Problem at Crown Tower Site, or Condemn Crown Tower?

The prospect of using a radio link instead of a land-line link for the applicant's facility was raised. According to the applicant, the tower at the McKay site is structurally "overloaded" with equipment and cannot safely support additional dish antennas on the upper portions of the tower. Such dish antennas would have been a way to provide a radio link to another tower site where there would be sufficient bandwidth to interconnect the facility to the applicant's network. Some concern was expressed by the applicant that the installation of a previous extension to the tower and the condition of the foundation may not meet current code for the load presently on the Crown tower.

These facts raise two competing questions. First, if the link problem can be resolved, does this eliminate the need for a new tower at 820 Main Street? Second, even if the link problem were resolved, is the Crown tower structurally unsafe and condemnable? Wireless bylaw section 3.10.6.5.d appears to provide the Planning Board some oversight of previously approved personal wireless service facilities:

> *The Planning Board may require that the equipment of all users of a Wireless Communications Facility shall be subject to relocation to another nearby facility if so directed by the Planning Board at a later time in its effort to maximize co-location of wireless service antennae. It may then order the removal of a facility after the relocation is completed.*

If the proposed tower is necessary and mutually exclusive with the Crown tower, it is logical to interpret a) the lack of interconnection bandwidth at the Crown tower and/or b) the possibility that the Crown tower is overstressed and unable to safely support all current co-locators, as indications that the Crown tower fails to maximize co-location. With the erection of the proposed

tower, if it were designed to maximize co-location in a manner that the Crown tower fails to, the Planning Board might have reasonable cause for action against the Crown tower under the above clause.

Mutually Exclusive in Acton

For communications in the cellular frequency band, the proposed tower is effectively a substitute for the Crown tower, and especially so for coverage within the boundaries of Acton. The prospects for PCS service from the two sites are more distinct because each site projects a smaller coverage footprint at PCS frequencies than at cellular frequencies. Fortunately, the PCS coverage obtained in Acton from the proposed tower replaces and extends the PCS coverage that would be available in Acton from the Crown tower. For serving Acton, the proposed tower provides better overall coverage in Acton. If it were to have suitable co-location capacity, the proposed tower would be mutually exclusive with the Crown tower, rendering the Crown tower obsolete for providing coverage in Acton.

We understand from the tenor of discussions at the hearing prior to the 820 Main Street Hearing on February 13, 2007, that the community is leaning toward a preference for minimizing the number of towers in town by maximizing their coverage in Acton and their co-location potential. Choosing the proposed tower as *a substitute for the Crown tower* would be consistent with this preference. Choosing the proposed tower *as a complement to the Crown tower*, because of co-location and/or interconnection bandwidth issues, seems inconsistent with the community preference.

Or: Preserve and Maximize Utility of Crown Tower

If it is determined to be the better choice to continue the use of the Crown tower instead of permitting the proposed tower, then another network link alternative should be considered (the applicant has agreed to explore this possibility): the telephone company link (estimated by the Verizon Wireless RF engineer to be perhaps equivalent to about 7 T-1 circuits or merely 11 megabits per second) could be beamed to the Crown tower from across the property.

Based on aerial photogrammetry we estimate the distance from the street to the tower to be about 780 feet. Closer, and on the adjacent property, is a large warehouse-like building which comes as close as about 244 feet to the tower. These two locations are potential points from which to extend a wireless link from the telephone company lines to the Crown tower site.

On the street, either an existing utility pole, or one erected for the purpose, could provide the final link between the tower compound and a terminal box on the utility pole. Telecommunications circuits are quite commonly terminated at utility poles, complete with electric meters and backup power supplies. In this case, the telephone company link could be provisioned to serve all wireless carriers at the Crown tower who seek more link capacity, terminated at the utility pole, and beamed across the treeless parcel to the tower. Concerns about the structural capacity of the tower for supporting a small link antenna may be a non-issue. Often when a tower is at or beyond its structural capacity in the top sections of the structure, the stresses at lower levels remain well within the limits. The result is that it is probable that a small antenna mounted at, say, 40-90 feet above ground would not exceed the stress limits of the tower. In the alternative, a utility pole (as tall as perhaps 80 feet if absolutely necessary) or a mast on an equipment shed could be installed on the leased area beside the tower to support the link antenna.

In lieu of beaming a link from the street, a link could be installed on the wall or roof of the adjacent warehouse structure. The telephone connection would be brought to the adjacent property and terminated at the wireless link. The link would beam to an antenna low on the tower or otherwise mounted as described above. This application of wireless technology for mission-critical communications links has a very long successful history. The equipment necessary to accomplish the task is commercial-grade and available off the shelf.

Height of Proposed Tower

The height of the proposed facility was also explored. The town requires maximum co-location capability to the extent that it is consistent with minimizing the facility's impact on its environs. The applicant supplied computer-estimated coverage plots for heights ranging from 90 feet to 175 feet. The result was that there were noticeable, but minor, differences in coverage between lowest and highest positions; this was true for both the cellular frequencies and the PCS frequencies. This suggests that to accommodate four wireless companies with two frequency bands each, a 130-140-foot tower would be sufficient, assuming the tree heights have been adequately estimated. Erring on the side of 140 feet helps make room for errors in estimation, and for the possibility that another personal wireless service might be spawned by future frequency auctions or sales.

Alternatively, it is not out of the norm to permit a pair of shorter towers on the same site, if the reduction in height outweighs the visual impact of two towers side by side (50 to 75 feet spacing is desirable). Carriers do have to contend with the nearby signal sources on the adjacent tower as

potential sources of interference, so this approach presents minor diminution in the convenience and potentially the performance of wireless facilities.

Coverage Comparisons

The combinations of three possible facility sites and two frequency bands make a complex relationship for analyzing the impact of the Board's decision. These issues are tabulated below. The sites are the proposed site, the North Acton Crown site, and the Post Office Square site. Verizon Wireless presently operates from the Crown tower at the Crown site and has the authority to occupy the PO Square site, but has not yet done so. The two frequency bands are cellular and PCS. PCS has less coverage area for a given site and antenna height than cellular service has. The table is written on the premise of ideal in-vehicle coverage. Ideal in-building coverage requires more facilities, and is mentioned in right column. Any site combination that assumes the Crown site is eliminated from the network will eliminate Crown coverage in neighboring towns; this evaluation of coverage does not consider neighboring towns and is limited to the impact of facility changes on Acton coverage.

Table of Characteristics of Various Facility Combinations

Facility Combinations	Cellular In-vehicle	PCS In-vehicle	Effectiveness in delivering quality of service where it is most useful
PO Square and Crown	Complementary coverage. Fills in northern Acton well.	Leaves about 1-mile "gap" along Main Street at less than ideal in-vehicle coverage	Good in-building coverage near town center and at PO Square, but leaves 820 Main Street area out of potential in-building grade of service.
Proposed only	Good coverage in northern Acton. Leaves spotty coverage in vicinity of Main Street south of Route 2A, but it might be tolerable along Main Street to town center. Development at Post Office Square may lack reliable in-vehicle service.	Creates an "island" of coverage with gaps in all directions.	In-building grade of coverage available only to commercial area near 820 Main Street.
Proposed and PO Square	Very good in-vehicle coverage throughout town in conjunction with Great Hill facility.	Pretty good fit for serving Main St region up to Westford line. Leaves "gap" area along Littleton line.	Concentrates in-building grade of coverage at two areas with dense commercial activity where it would be most useful.
Proposed and Crown	Substantial duplication of coverage. See Proposed Only description for impact south of 2A near Main Street.	Some duplication of coverage.	Good in-building coverage at 820 Main area, but lacking at PO Square and near town center.
Proposed, PO Square, and Crown	Substantial duplication of coverage among all three facilities.	Some duplication of coverage (with Crown)	The addition of Crown in-building service levels is not particularly beneficial as the area it serves is largely undeveloped. See Proposed and PO Square for their contributions.

Note that in-building and in-vehicle grades of service are not pass/fail thresholds, but are ideal signal level thresholds. Substantial in-building and in-vehicle service can be obtained at signal levels somewhat lower than the ideal, with a corresponding diminution in reliability.

Conclusion

The Crown tower complicates the decision-making process. Looking backward, the Crown tower is already approved and in use. There appears to be more than one way to resolve the land-link bandwidth problem, making the proposed tower unnecessary.

Looking forward, the proposed tower is more effective at providing coverage to Acton. At PCS frequencies, the Crown tower leaves an apparent gap along Main Street between its service area and that of the Post Office Square site. PCS carriers might seek to serve this gap in the future

David Maxson
Municipal Wireless Consultant
Broadcast Signal Lab, LLP
503 Main Street
Medfield, MA 02052